BASIC JOINTS FOR TIMBER

BASIC JOINTS

Timber joints are designed to allow lengths of timber to be connected in a variety of shapes and forms using the simplest, strongest most efficient means. When choosing a joint for a particular job, the following must be considered:

- Performance;
- Economy; and
- Practicability.

Once the joint is chosen it must be marked, accurately cut and assembled using a suitable fastening system.

Basic Construction Joints

Overlap Joints

These joints are strong and simple and can be used for general purpose jobs. The joints may be nailed, screwed or bolted and are mainly designed for use where appearance is not critical.

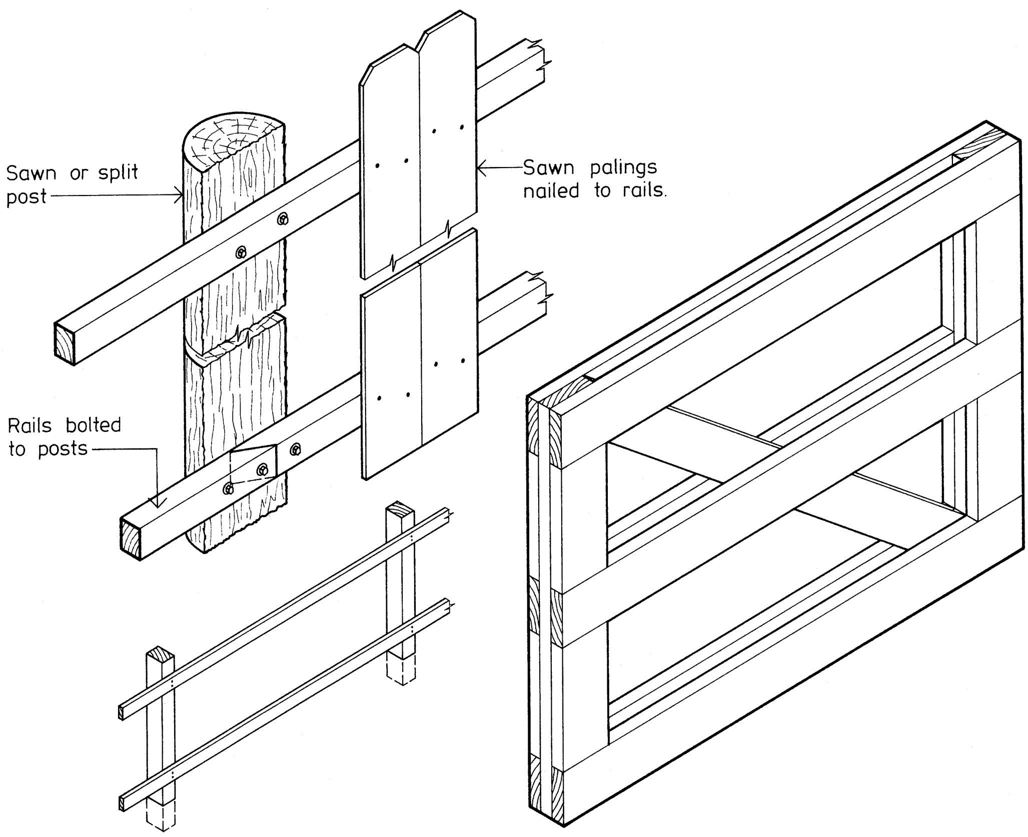


Fig. 83 Post and rail Built-up Gate

Butt Joint

This is the simplest joint used in construction, joinery or the furniture trades. The joint may be held together with nails, screws, wriggle nails, nail plates, 'Gangnail' plates, angle brackets or patent type connectors. In construction work, they are commonly used where noggings meet studs in wall frames, top and bottom wall plates intersect, bottom chords of trusses are joined in length, ties and webs are connected to top and bottom chords in trusses, floor trimmers abut floor joists, etc.

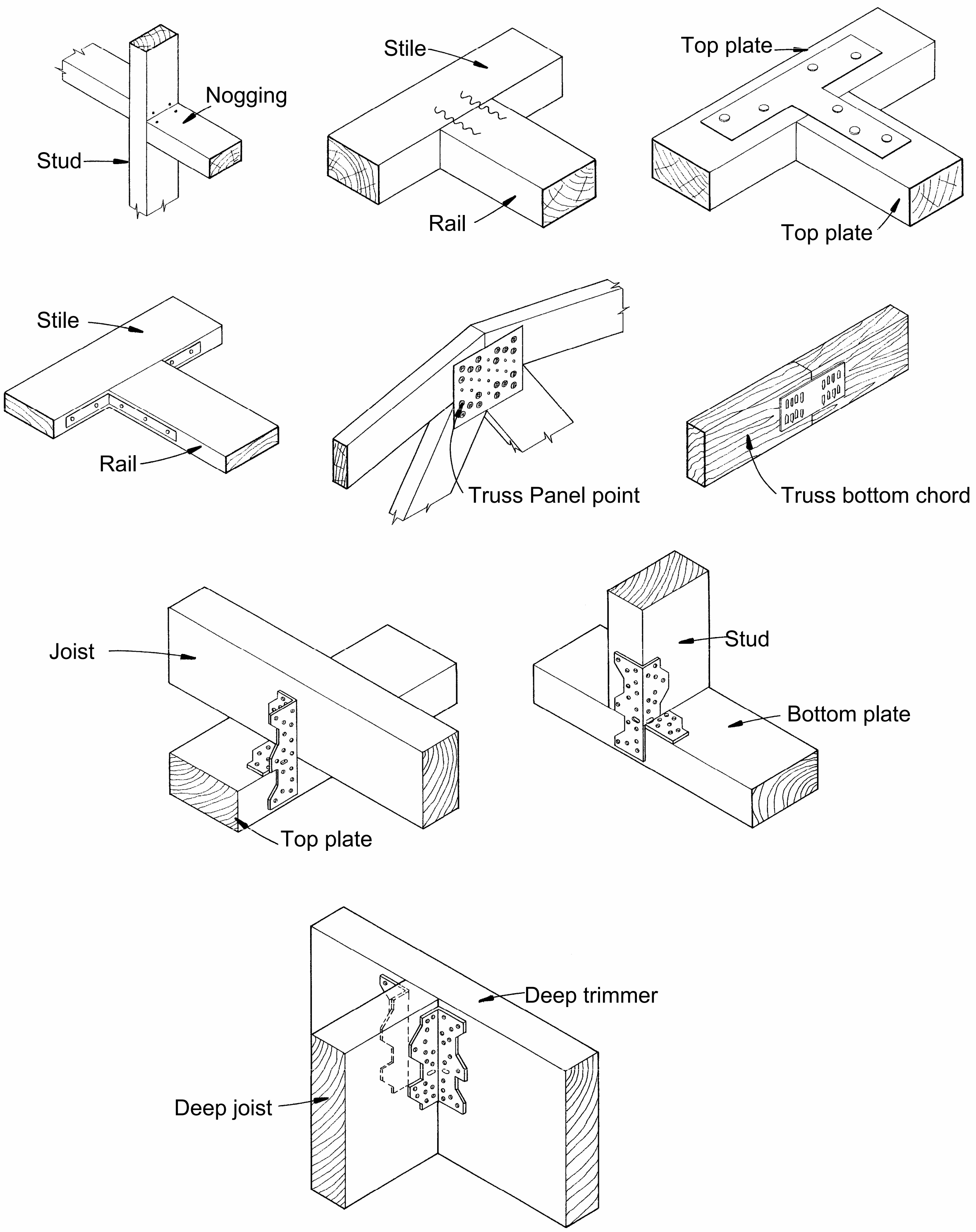
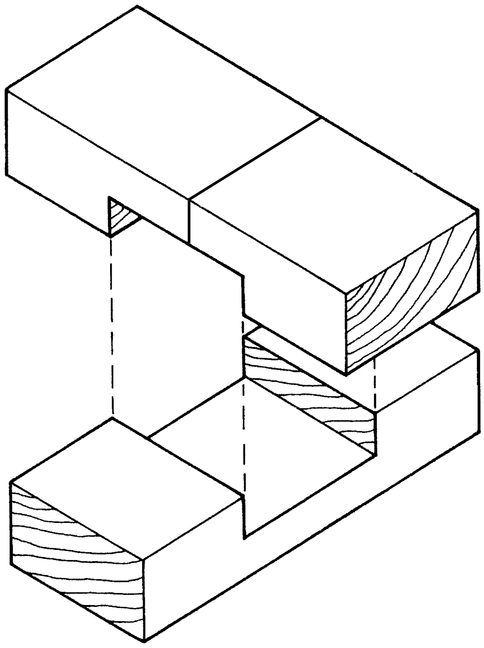


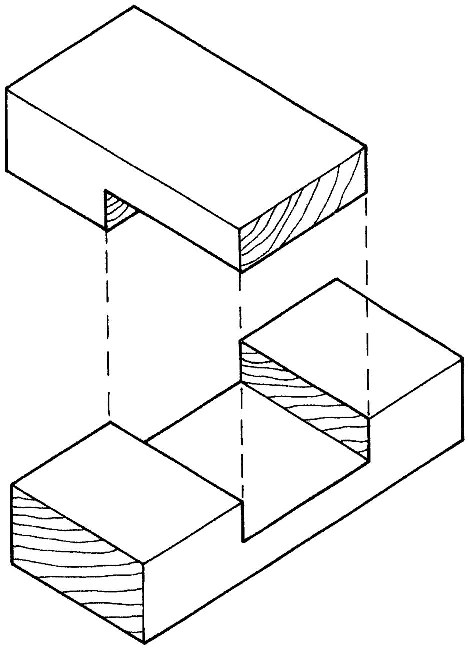
Fig. 84 Common use of Butt joints

Halving Joints - for wall framing

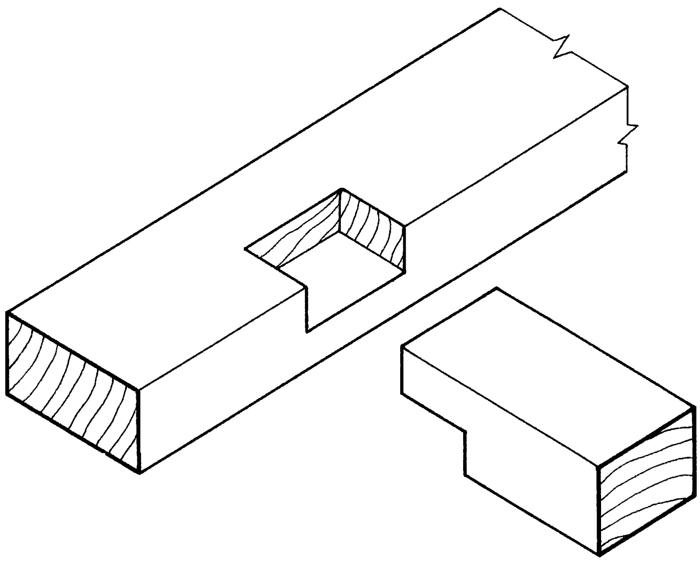
There are a number of uses for halving joints in construction but the most common uses are in wall frame construction and connection, eg. cross halvings may be used where internal walls intersect at a common position, Tee halvings may be used where an internal wall connects to an external wall, corner halvings may be used where internal or external walls connect at an internal or external corner, and stopped housings may also be used to connect wall plates at 'T' intersections.



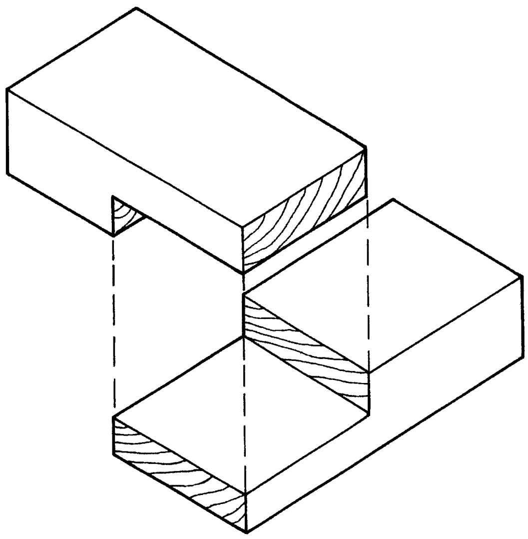
CROSS HALVING JOINT



TEE HALVING JOINT



STOPPED HALVING JOINT

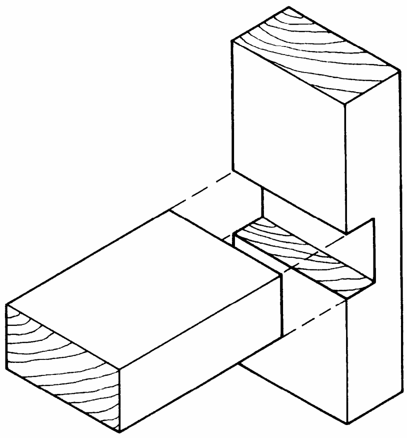


CORNER HALVING JOINT

Fig. 85 Various wall framing joints

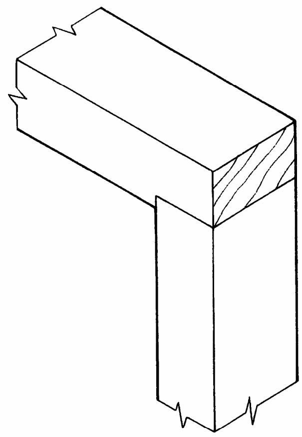
Housing Joints

These joints may be used in construction or joinery work. The most common types and uses in the construction area are the:- through housing used mainly to connect studs to wall plates or sill and head trimmers to door or window studs, end lap housing used to connect a stud to wall plates at the end of a wall, side housing used to connect trimming or braces to the face of a wall frame and the stopped housing used to connect floor trimmers to the sides of joists around an opening, fireplace, etc.



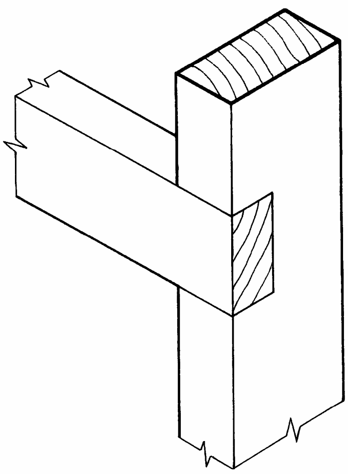
Plates to partition and external walls.
Overhanging plates.

THROUGH HOUSING



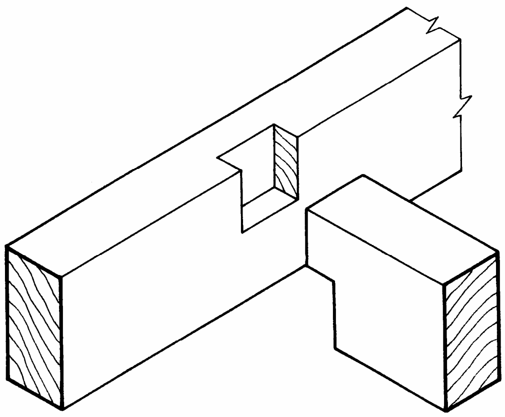
Partition walls. Plates to end studs.

END-LAP HOUSING



Bracing Trimming.

SIDE HOUSING



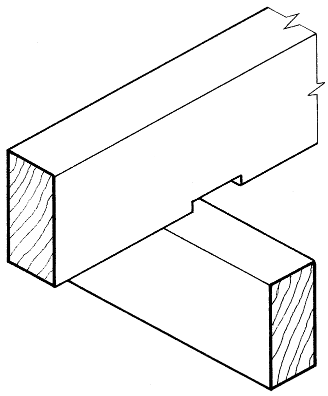
Trimming

STOPPED HOUSING

Fig. 86 Various Housing joints

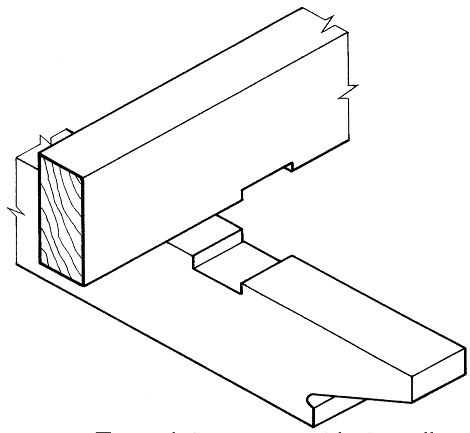
Notched, Cogged and Checked Joints

These joints have a variety of uses and may be applied in the following situtions: - notched joint may be used to create a level top surface to a floor by checking out the bottom edge of rough sawn joists to fit over bearers, double notched joint and the cogged joint may be used to connect rafters to beams of pergolas or open frame structures to prevent the members twisting, and the checked joint may be used where wall framing jack or soldier studs are to be checked around the lintel of a window or door opening.



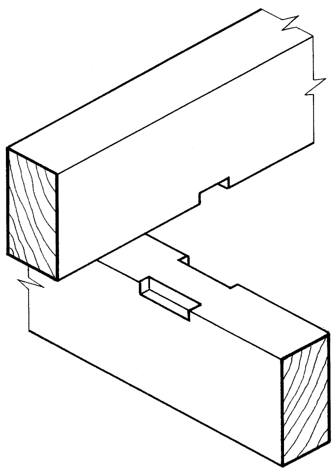
Levelling joists over bearers.

NOTCHED JOINT



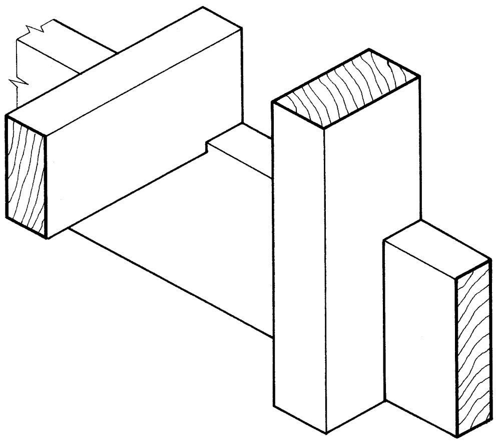
To resist movement in two directions in pergolas.

DOUBLE NOTCHED JOINT



To resist two-way lateral movement.

COGGED JOINT



Jack studs to heads struts to purlins.

CHECKED JOINT

Fig. 87 Various framing joints

METHOD OF CONSTRUCTION FOR A CORNER HALVING JOINT

The following steps outline the method used to set out, cut and assemble a *corner halving joint* for a timber wall frame:

STEP 1 Mark the face side of each piece, then use the opposite piece to mark the width of the joint on the waste side of each piece. Square across the face of the top of one piece and the bottom of the other and place an 'X' on the waste section to be cut out;

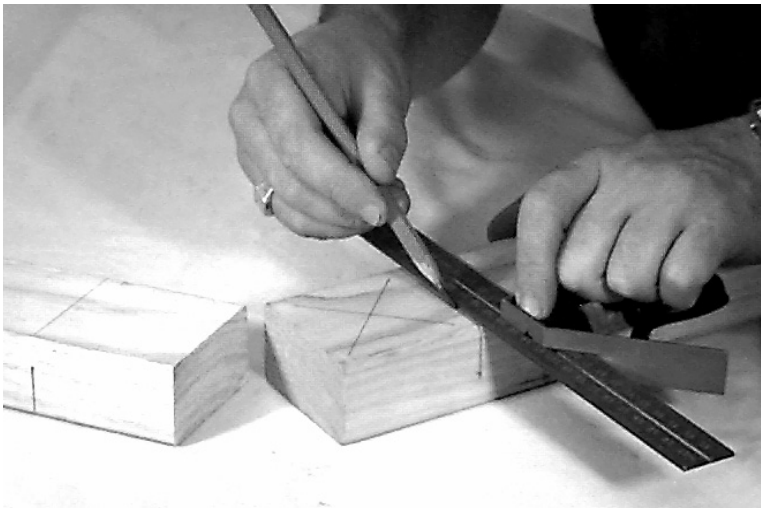


Fig. 88 Mark out waste sides

STEP 2 Using a marking gauge or a combination square and pencil, gauge the depth of each piece from the same side, equal to half the thickness of the pieces. It is essential that gauging be carried out from the same side of each piece, ie. both from the top or both from the bottom, so that any variation in thickness will still allow the pieces to be *flush* on at least one side. Square down the edges to the waste line;

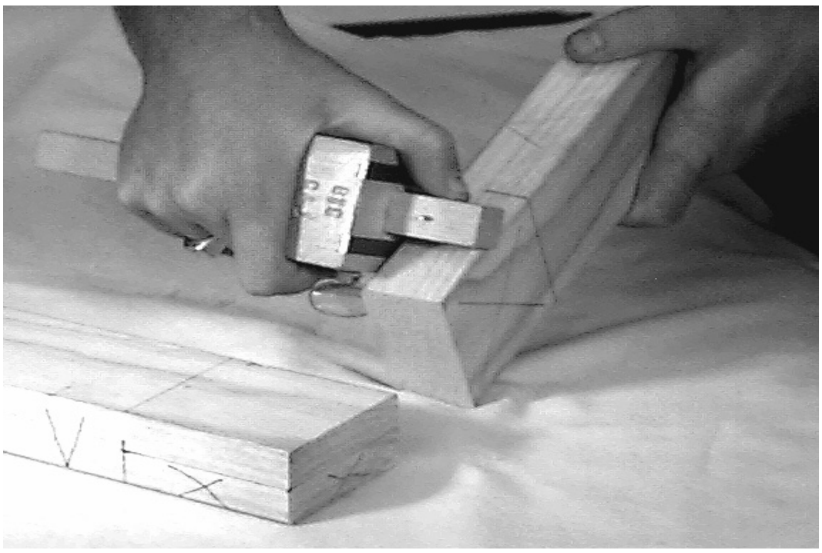


Fig. 89 Gauge the thickness of each piece

STEP 3 Using a rip saw, rip down the edge on the waste side of each piece, to the shoulder line;

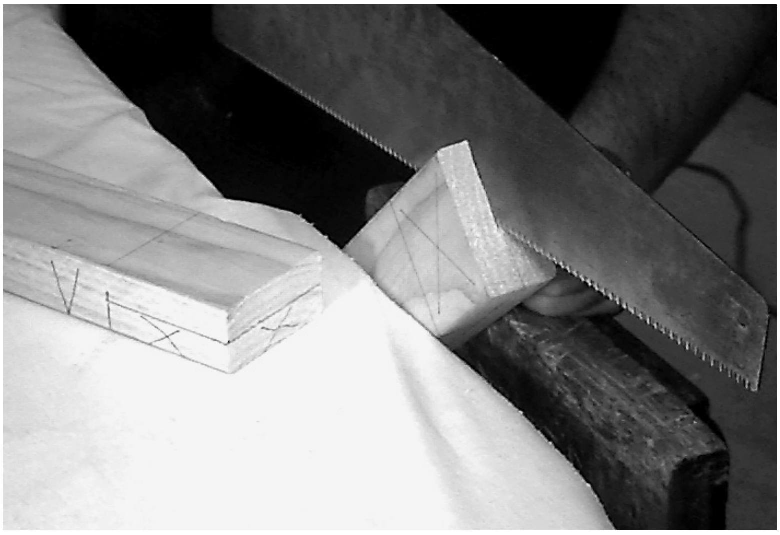


Fig. 90 Rip down the edge

STEP 4 Using a cross cut saw, cut square across the shoulder line to the depth of the rip. Remove the waste and try the joint for fit;

Fig. 91 Cut across the shoulder

STEP 5 If the two faces require some fitting, use a wide sharp chisel to pare off small amounts to allow for a neat fit. Place the two pieces together at right angles for final fit.

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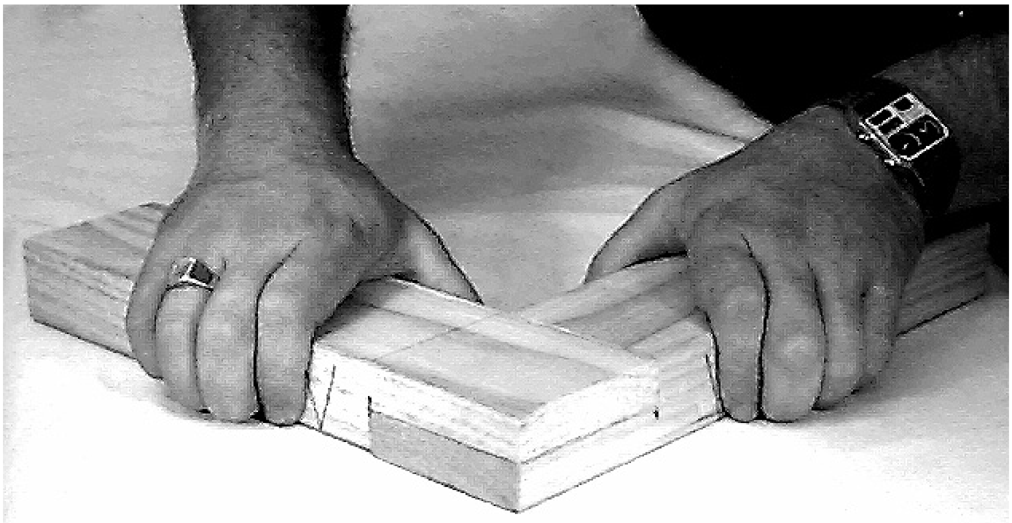


Fig. 92 Fit the joint

NAILING TECHNIQUES

Selecting nail lengths

To find the length of nail required to attach two pieces of timber together, a simple rule to follow would be that if the grain of the two pieces is parallel, use a nail which is two to two and a half times the thickness of the first piece of timber (as shown below). When one piece is nailed on to the end of the other piece, the nail should be two and a half to three times as long as the outer piece is thick (as shown below). The ‘ SAA Timber Structures Code’ - AS 1720.1-1988 states that nails should penetrate the second member by ten times the nail diameter.

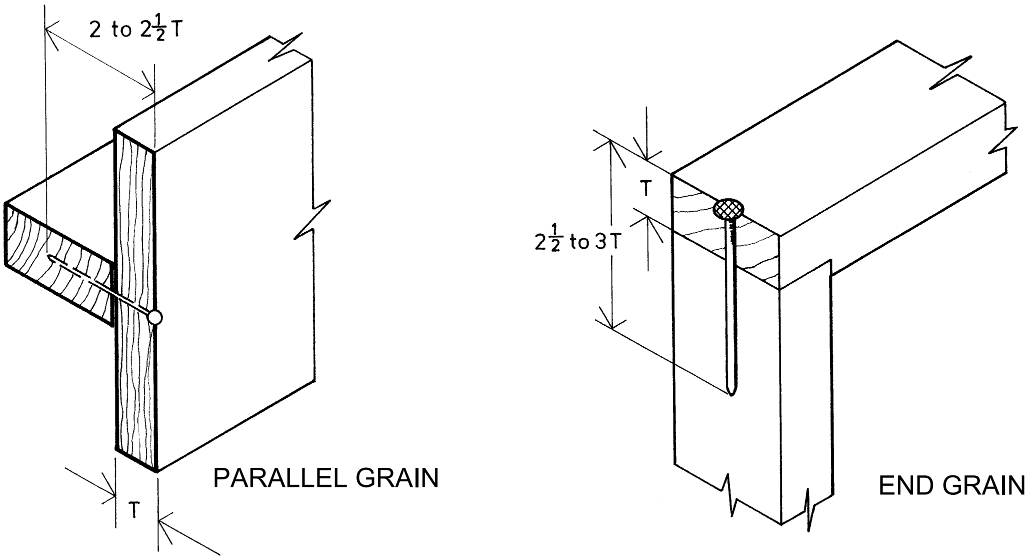


Fig 93 Selecting nail lengths

Using Special Fasteners

Ordinary smooth shank fasteners tend to pull out easily from materials like particleboard therefore it is necessary to use a suitable fastener with a textured shank as found with the ‘helical’ and ‘annular’ types. They are easily driven but resist working loose by grabbing onto the coarse fibres in manufactured boards and soft timbers.

Ordinary nails tend to work loose in some applications.

Helical particle board nails drive easily without damaging the fibre and strongly resist pulling loose.

Annular nails grip the fibres well in softwood and resist working loose.

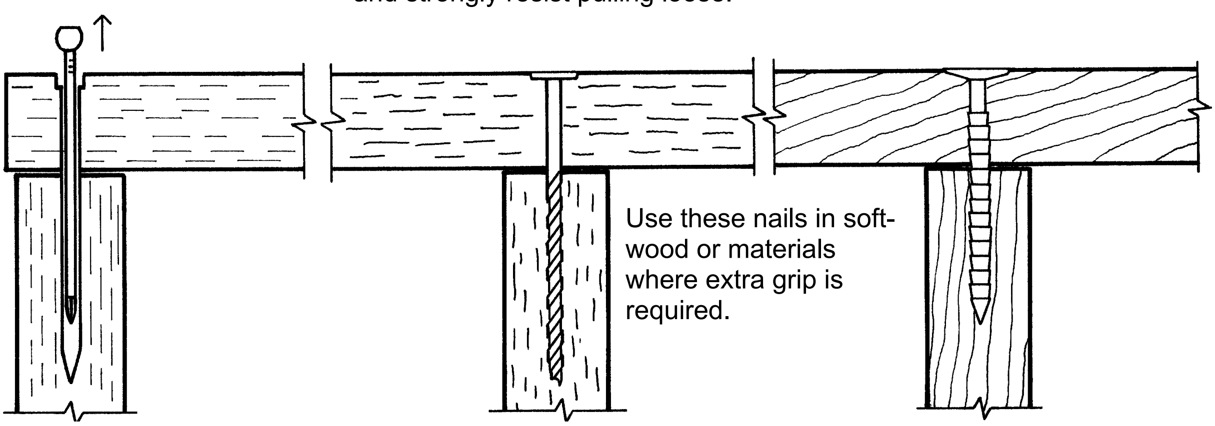
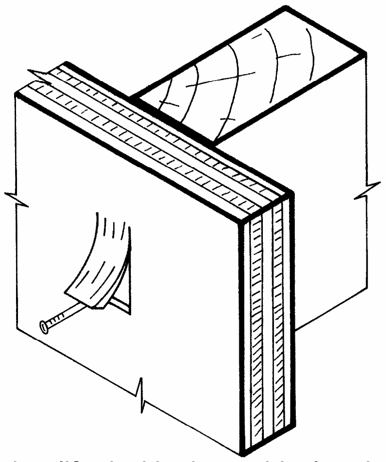


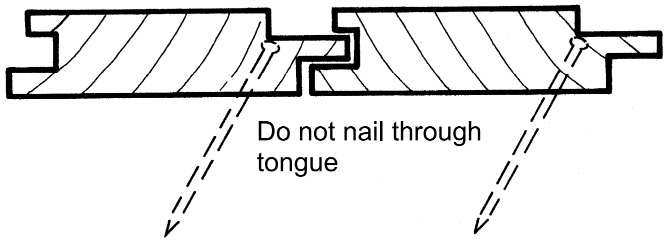
Fig. 94 Use of special fasteners

METHODS OF NAILING

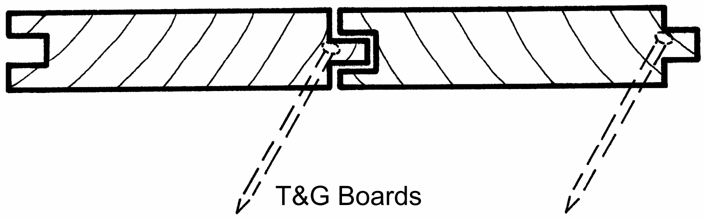


Timber lifted with sharp chisel and glued down over punched nail

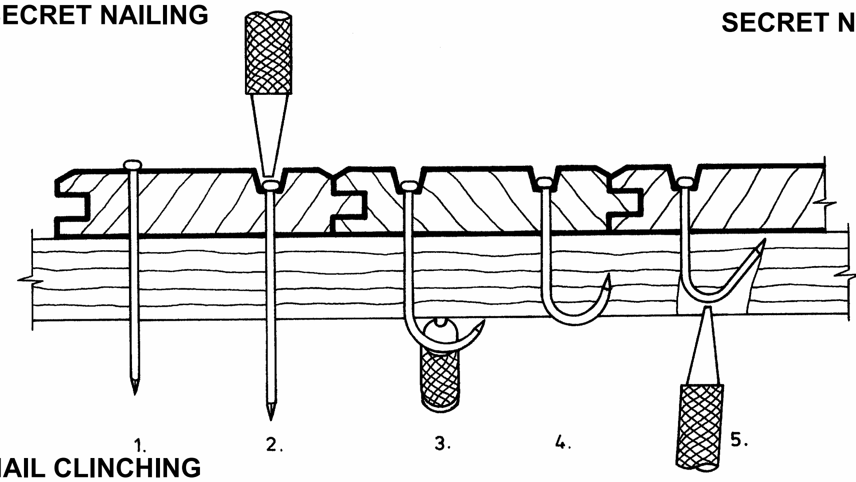
SECRET NAILING



SHIPLAP BOARDING

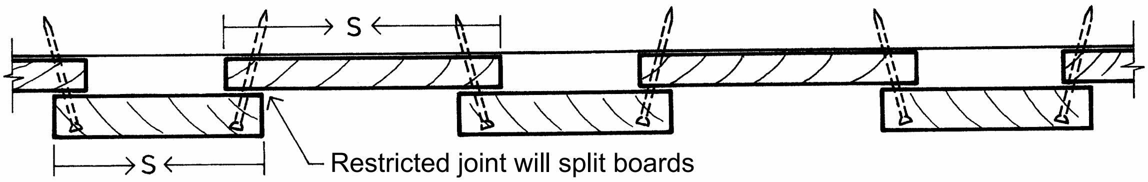


SECRET NAILING

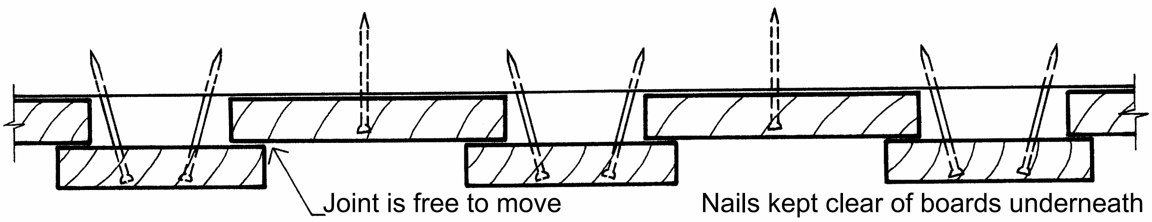


1. Drive the nail through.
2. Punch well down.
3. Bend over nail punch.
4. Clinch into timber.
5. Punch down

NAIL CLINCHING



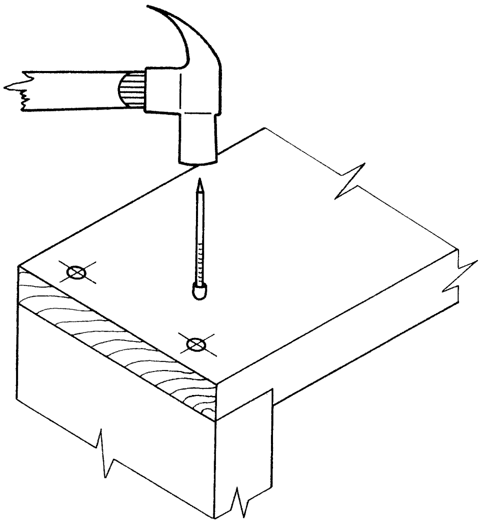
INCORRECT: 'S' Shrinkage causes splitting of the boards



CORRECT: Method of Nailing the boards

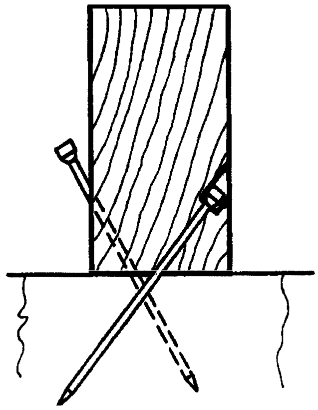
NAILING LAPPED PALINGS OR LINING

Fig. 95 Secret nailing and Clenching



Use fine gauge nails when near to the edge and the end of timber. Nail is driven head first slightly into timber to form recess and flatten point, then when driven in normal way helps prevent splitting.
Holes may have to be drilled to prevent splitting close to edge or end of timber, select drill diameter slightly less than nail diameter so

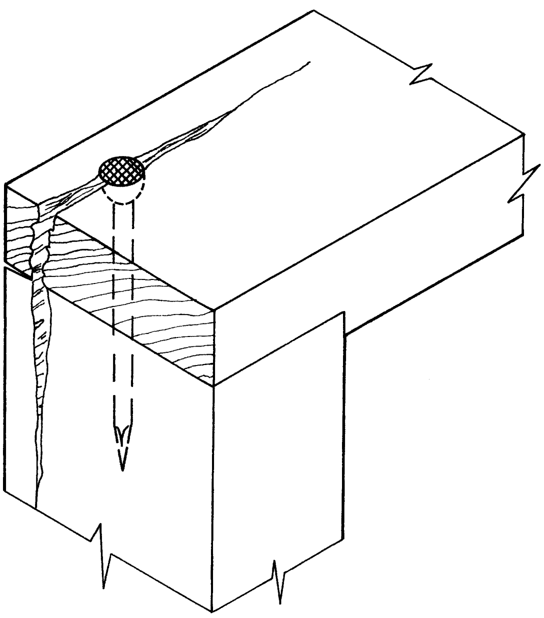
CORRECT WAY OF NAILING NEAR END



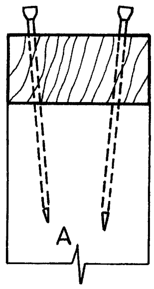
Nails skewed approx. 45°
Punch nails below surface
Application: Joists to bearers.

SKEW NAILING

If nail gauge is too heavy, it will cause splitting use a lighter gauge.

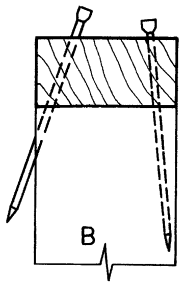


INCORRECT NAILING AT END



Correct

A. Deep penetration gives good holding power.
B. Nails penetrate or are dangerously close to the surface. This causes splitting and reduces holding power.



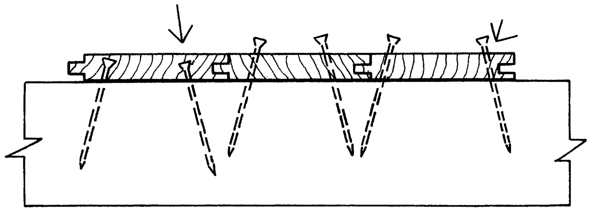
Incorrect

Application: Plates to studs

DOVETAIL NAILING

Punch nails below surface off boards

Care is required to prevent splitting. Do not nail too close to edge



NAILING OF T&G FLOORING

Fig. 96 Nailing for maximum hold and prevention of splitting

DRIVING SCREWS

Screws should be driven with a manual screw driver or electric screw gun, never using a hammer. When using a manual screwdriver the blade should fit so that it bottoms in the screw slot and does not extend past the head of the screws. It should also fit neatly in the width of the slot to avoid stripping the slot. This is also essential when using a 'Phillips' head screwdriver or a 'Posidrive' screw gun bit.
Coach screws are driven with a correct fitting spanner.

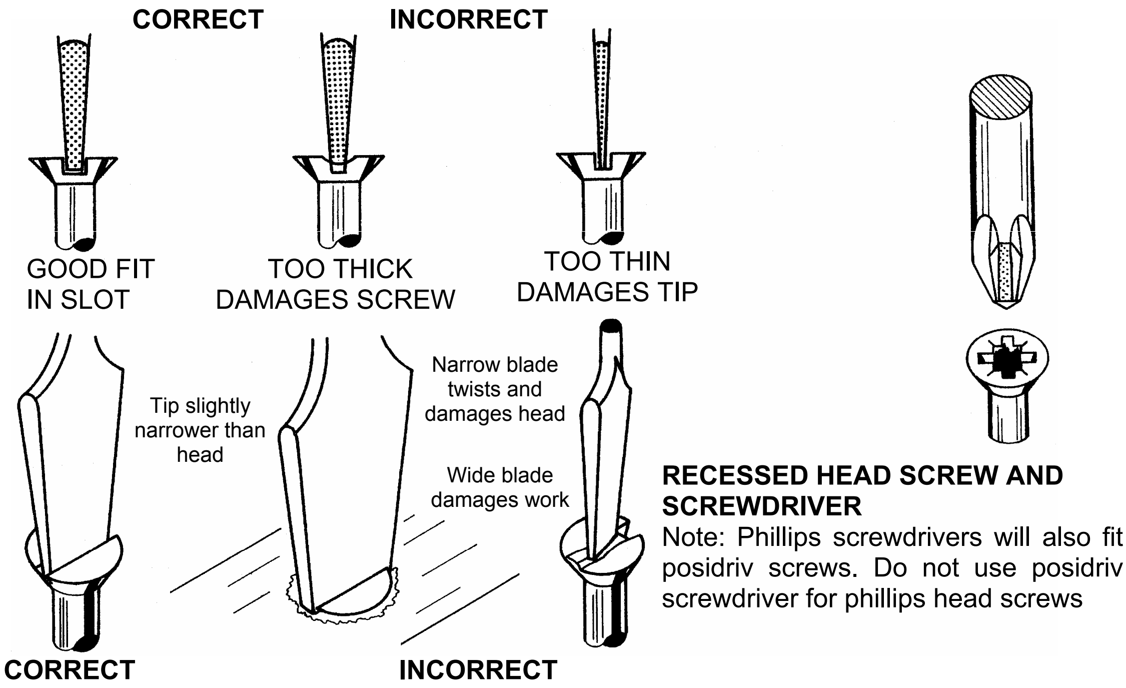


Fig. 97 Selecting the correct screwdriver

Preparation of Screw Fitting

To prevent the timber from splitting, and to make fitting the screw easier, it is necessary to prepare the job by creating a pilot hole. The first member is bored to clear the diameter of the shank of the screw and the surface is countersunk, if a countersunk head type screw is being used. In softwood, a bradawl hole in the second member is enough as the screw will draw it's way into the timber. However, in hardwood or dense timbers it will be necessary to drill a hole half the shank diameter, to allow easy insertion. The use of a friction breaking agent such as light grease or wax will allow the screw to be easily fitted.

1. **CLEARANCE HOLE**
2. **PILOT HOLE**
3. **COUNTERSUNK**
4. **POSITIONED**

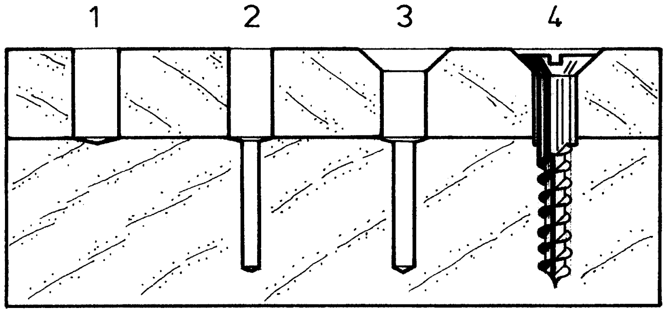


Fig. 98 Preparing the timber for screw insertion

Dressing or Heading the screws

Once the screws are fitted tightly, the appearance requires some attention. This is done by turning all the heads so that the slots run in the same direction. This is called '*heading*' the screws. It is a vital part of the fixing out process where the screws are highly visible such as the hinges of hung doors, door furniture, wall and ceiling fittings, etc. When using posidrive screw heads they do not require heading.

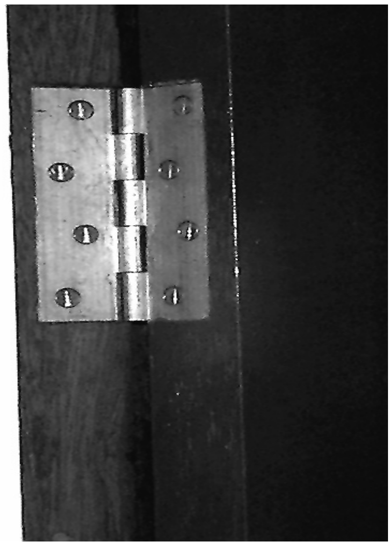


Fig. 99 Heading the screws

INTRODUCTION TO CALCULATIONS

The present units used in building calculations are based on the universal system known as 'Système International d´Unitès' , more commonly referred to as 'S.I. units'. The following details outline the most common units:

Linear measure - the length of an element or surface

1 metre (m)	=	1000 millimetres (mm)
1 kilometre (km)	=	1000 metres (m)

NB: *Centimetres* are not formally recognised in the building industry, therefore only metres and millimetres are used.

Square measure - the area, or length x width, of a surface

1 metre (m) x 1 metre (m)	=	1 square metre (m^2)
1 acre	=	100 square metres (m^2)
1 hectare	=	100 ares or 10 000 (m^2)

Other commonly used square measures are those converted from the old Imperial system of measurement, such as:

1 building 'Square'	=	10 feet x 10 feet (100 sq.ft.) or 9.290 (m^2)
1 acre	=	4000 (m^2), therefore the old ¼ acre building block would be equal to 1000 (m^2)

Volume - is the amount of space created by a three dimensional object :

1 metre (m) x 1 metre (m) x 1 metre (m)	=	1 cubic metre (m^3)
1 litre (l)	=	1000 millilitres (ml) or 0.1 cubic metre (m^3)
1 kilolitre (kl)	=	1000 litres (l) or 1 cubic metre (m^3)

Mass - is the quantity of matter or the density of matter:

1 gram (g)	=	1000 milligrams (mg)
1 kilogram (kg)	=	1000 grams (g)
1 tonne (t)	=	1000 kilograms (kg)

1 ml of water at 4ºC has a mass of 1 gram (g) and 1 litre of water has a mass of 1kilogram (kg).

Mathematical Signs, Terms and Abbreviations

=	means equal
+	means to add, plus or the sum of---
-	means to subtract, minus, deduct or the difference between---
x	means to multiply, times or the product of---
÷	means to divide, the divisor or the quotient of---
∴	means therefore
i.e.	means that is
e.g.	means for example

A digit is the name given to any number

USING DECIMALS

In all trade calculations it is important to keep the *digits* in their correct columns and immediately underneath. Do not use a comma (,) as a decimal marker or as a thousands separator. A gap between groups of three figures, counted from the decimal point, should be used.
e.g. 6 093.969 72
When a value is less than one, a zero should be put in before the decimal point and always show zero's as place holders with answers rounded off to three decimal places.
e.g. 0.400, 0.017, 0.007, etc.
The number, one thousand seven hundred and sixty four is written 1 764 or 1.764 and has each of the digits in its correct place and order.
e.g.

1	**7**	**6**	**4**
T	H	T	U
h	u	e	n
o	n	n	i
u	d	s	t
s	r		s
a	e		
n	d		
d	s		
s			

Rounding Off

When the sets have too many decimal places, they can be 'rounded off' so they are easier to use. As a general rule small digits, 01234, are rounded down and large digits, 56789, are rounded up.
e.g.

1.7964	is rounded down to	=	1.796
1.7965	is rounded up to	=	1.797
5.00288	is rounded up to	=	5.003
6.9997	is rounded up to	=	7.000

Place Holders

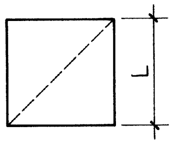
When adding, subtracting, multiplying and dividing, it is necessary to show the zero's even though they don't represent any amount. This will assist the neat and accurate layout of all calculations and reduce the possibility of errors.
e.g.

6.070							
12.300	+	34.06	-	15.25	×	24.00	÷
0.996		15.10		0.060		0.030	
19.366		18.96		0.915		800.2	

SIMPLE FORMULAE

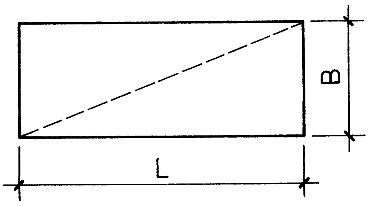
Square

The simple formula for the perimeter is 4 x length of one side or 4 x L
The simple formula for the area is the length of one side x the length of the other side or L^2



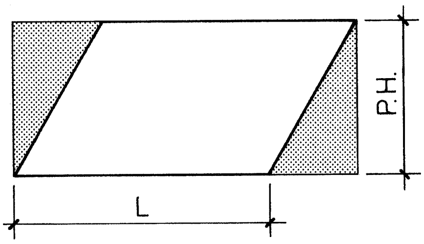
Rectangle

The simple formula for the perimeter is twice the length plus the width or breadth or 2 x (L+B)
The simple formula for the area is the length x the breadth or width or L x B



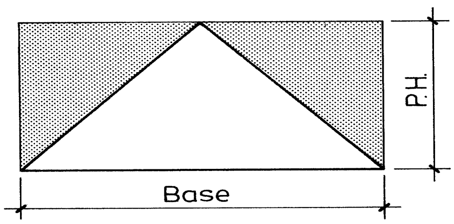
Parallelogram

The formula for the perimeter is the addition of the length of all four sides
The formula for the area is the length x the perpendicular height or L x PH



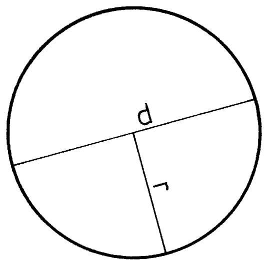
Triangle

The formula for the perimeter is the addition of all three sides
The formula for the area is the base x perpendicular height, divided by two or Base x PH



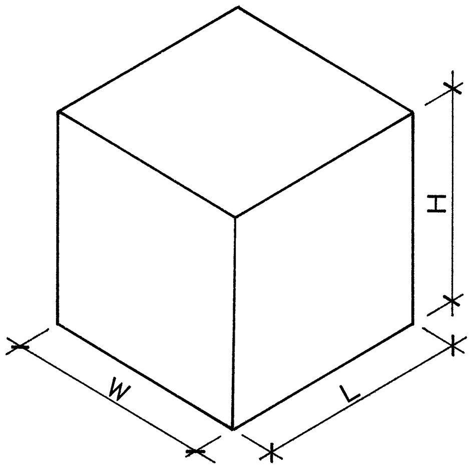
Circle

The formula for the circumference is pi (π) x the diameter or two x the radius, ie. π d or 2 π r
The formula for the area is pi (π) x the radius squared or πr^2.
Note: pi (π) = 3.142 or $3\frac{1}{7}$ or $\frac{22}{7}$



Volume

The formula for volume is the length x the width x the height or L x W x H



INTRODUCTION TO QUANTITIES AND COSTS

Common formulae used in carpentry calculations are linear, square and volume. They are commonly used to calculate the quantities and costs of timber, sheet materials, brickwork and concrete.

TIMBER

Timber quantities are usually calculated by linear metre, as are the costs, except where large section sizes are involved or great quantities are calculated, in which case volume is used.
The same section sizes of timber are usually grouped together and the individual pieces are identified, in lengths of 300mm increments, then added together to obtain a total linear measurement for that particular section size. Sheets are calculated by number per surface.

Lengths available

As previously mentioned, timber is available in lengths of 300mm increments, ie. when ordering timber it must comply with the standard length policy, e.g:
The shortest available length from a timber yard is usually 1.8m, therefore the next available lengths would be 2.1, 2.4, 2.7, 3.0, 3.3, 3.6, and so on to a maximum length, in most timber yards, of 7.2m.

LINEAL

Once the various lengths have been *taken off* or calculated from the plan, they need to be grouped together as common materials and common section sizes. The total lineal metres are calculated for each group, a rate per lineal metre is found and then the two are multiplied together to find a cost. All costs may be added together at the end to form a total price for materials, as follows:

Like section sizes and materials are grouped together:

SECTION	MATERIAL	QUANTITY	LINEAL
100 x 50	R.S. hardwood -	20/4.8, 5/3.6, 12/2.4	142.8m
100 x 50	R.S. hardwood -	5/4.5, 7/4.2, 15/3.9	110.4m
100 x 50	R.S. hardwood -	20/4.5, 10/3.3, 14/2.1	152.4m
		TOTAL LINEAL METRES	**405.6m**

The total lineal metres are multiplied by the rate per metre e.g. $3.20, to find the total cost;

Total lineal metres = 405.6 x $3.20 = **$1,297.92**

Where the section sizes or materials are different, a separate rate will apply for each different section size and/or material, and each will have to be calculated separately. A total cost may be calculated at the end by adding all the separate costs together, as in the following example:

SECTION SIZE	MATERIAL	QUANTITY	LINEAL METRES	RATE Per m. square	COST
70 x 45	Radiata pine	2/5.4, 12/4.8, 2/4.5	77.4m	$1.95	$150.93
100 x 50	R.S. hardwood	25/4.8, 15/3.6	174.0m	$3.20	$556.80
100 x 50	R.S. Oregon	5/3.9, 20/3.6, 15/2.7	132.0m	$3.40	$448.80
140 x 45	Radiata pine	8/3.6, 10/3.0	58.8m	$4.70	$276.36
				TOTAL COST	**$1,432.89**

SURFACE AREA

When calculating the quantity of sheet materials it is necessary to use the standard sheet sizes for the particular job. Generally, standard sheet sizes range from 0.9 x 0.9m to 3.6 x 1.2m, depending on its use. To find the number of sheets required it is necessary to divide the total area of the job by the area of one sheet. The cost is based on the price per sheet.

Example 1:

To calculate the number and cost of 3.6 x 0.9m structural particleboard flooring sheets required to cover a floor measuring 10.5m long x 6.8m wide, the following is carried out:

Area of one sheet of flooring = 3.6 x 0.9 = 3.24m²

Area of the floor = 10.5 x 6.8 = 71.40m²

Therefore, 71.40 ÷ 3.24 = 22.037 , say **23 sheets**

The total number of sheets is multiplied by the rate per sheet, $24.00, to find the total cost;

Total number of sheets = 23 x $24.00 = **$552.00**

Example 2:

To calculate the number of 2.4 x 1.2m sheets of ply required to cover a wall 6.8m long x 2.7m high, the following is carried out:

Area of one sheet of ply = 2.4 x 1.2 = 2.88m²

Area of the wall = 6.8 x 2.7 = 18.36m²

Therefore, 18.36 2.88 = 6.375, say 7 sheets

The total number of sheets is multiplied by the rate per sheet e.g. $52.00, to find the total cost:

Total number of sheets = 7 x $52.00 = $364.00

Volume

The like section sizes and materials are grouped together and a total lineal length is calculated, then the length is multiplied by the width, and then by the thickness to obtain a total number of timber for that section size where section sizes have the same price per cubic metre, they too may be grouped together and then multiplied by the rate, e.g. $865.00 per m3, to obtain a cost as follows:

Like section sizes and materials are grouped together:

SECTION SIZE	MATERIAL	QUANTITY	LINEAL METRES
100 x 50	R.S. hardwood -	20/4.8, 5/3.6, 12/2.4	142.8m
100 x 50	R.S. hardwood -	5/4.5, 7/4.2, 15/3.9	110.4m
100 x 50	R.S. hardwood -	20/4.5, 10/3.3, 14/2.1	152.4m
		TOTAL LINEAL METRES	**405.6m**

Therefore the total lineal metres are multiplied by the section size, to find the volume, then multiplied by the common rate, to find a cost:

Volume = 405.600 x 0.100 x 0.050 = **2.028m³**

Cost = 2.028 x $640.00 = **$1,297.92**

Where the section sizes or materials are different, a separate rate will apply for each different section size and/or material, and each will have to be calculated separately. A total cost may be calculated at the end by adding all the separate costs together, as in the following example:

Example 3:

SECTION SIZE	MATERIAL	QUANTITY	LINEAL METRES	CUBIC METRES	RATE per m³	COST
70 x 45	Radiata pine	2/5.4, 12/4.8, 2/4.5	77.4m	0.290m³	$619.00	$179.51
100 x 50	R.S. hardwood	25/4.8, 15/3.6	174.0m	0.870m³	$640.00	$556.80
100 x 50	R.S. Oregon	5/3.9, 20/3.6, 15/2.7	132.0m	0.660m³	$680.00	$448.80
140 x 45	Radiata pine	8/3.6, 10/3.0	58.8m	0.335m³	$746.00	$249.91
					TOTAL COST	**$1,435.02**

***Note:** There may be a slight difference in price between the lineal cost and the volume cost, for the same original quantities, due to rounding up of cubic metre quantities.*

BRICKWORK

Bricks are calculated by number based on a rate or average number of bricks, per 110mm thick skin of brickwork, per m². The surface area of a wall or paved area is calculated, then multiplied by the rate/m². The cost of bricks is based on a price per thousand for a particular style, colour and finish. The average number of bricks found in one 110mm thick skin x 1m² = **50.**

Example 1:

To calculate the number of bricks in a single skin, 110mm thick, of a garage wall 5.750 long x 2.410 high, it is necessary to carry out the following:

Area of the wall	=	5.750 x 2.400	=	13.800m²
Number of bricks per m² per 110mm skin	=	50 x 1 skin	=	50

Therefore, 13.800 x 50 = **690 bricks.**

The total number of bricks are multiplied by the rate per thousand, e.g. $760.00, to find the total cost:

Total number of bricks (in thousands) = 0.690 x $760.00 = **$524.40**

Example 2.

To calculate the number of bricks in a solid or double skin, 230mm thick, garden wall 10.550m long x 0.946m high, it is necessary to carry out the following;

Area of the wall	=	10.550 x 0.946	=	9.980m²
Number of bricks per m² per 110mm skin	=	50 x 2 skin	=	100

Therefore, 9.980 x 100 = **9,980 bricks.**

The total number of bricks are multiplied by the rate per thousand, e.g. $760.00, to find the total cost:

Total number of bricks (in thousands) = 9.980 x $760.00 = **$7,584.80**

CONCRETE

Concrete is calculated by volume, whether it be for a slab-on-ground, a strip footing, a retaining wall, a footpath, etc. The total length is calculated first, especially for strip footings, then multiplied by the width, then by the depth. The cost is based on a rate per m³ related to the strength in Megapascals (MPa). Quantities are rounded up to the nearest 0.2m³

Example 1.

To find the volume of a 100mm thick, 20MPa concrete slab-on-ground measuring 6.500m long x 2.700m wide, the following is carried out:

Volume of the slab = 6.500 x 2.700 x 0.100 = 1.755m³

Therefore, the total volume of concrete = 1.755 , order **1.8m³**

The total volume of concrete is multiplied by the rate per cubic metre, e.g. $175.00 delivered, to find the total cost:

Total volume = 1.8 x $175 = **$315.00**

***Example 2*:**
To find the volume of a 75mm thick, 15MPa concrete path measuring 8.600m long x 0.800m wide, the following is carried out:

Volume of the path = 8.600 x 0.800 x 0.075 = 0.516m³

Therefore, the total volume of concrete = 0.516 , order **0.6m³**

The total volume of concrete is multiplied by the rate per cubic metre, e.g. $158.00 delivered, to find the total cost:

Total volume = 0.6 x $158.00 = **$94.80**

FORMAL DRAWING

Drawings are one of our most important means of communication. As we learn to draw, we are also learning to read the information on a drawing sheet and understand how things are put together.
Working drawings come with a specification, or a written description of the work, which provides information about the materials, method of fixing and the finish required and in combination they allow very complex structural elements to be designed and constructed.
Drawings may be presented in several ways. The conventional method is to use pencils, ink pens and associated instruments to manually draw all the details. More recent methods include the use of computers with programs like CAD (Computer Aided Drafting) to allow the designer to create details quickly, accurately and be able to see the image in three dimensions viewed from any side.
To understand the principles involved in high technology drafting, it is useful to be able to firstly draw manually using conventional equipment, as follows:

EQUIPMENT

Drawing Paper
The main classifications of drawing paper are:

- Hand-made paper for specialist use;
- Machine-made papers; and
- Tracing paper.

Hand-made - these papers are available in standard sheet sizes with finishes ranging from smooth, medium grade and rough. They are usually expensive and mainly used for ink and pencil drawings. They will take the application of ink washes and gouaches (water paint) to allow for the images to be rendered or shaded.

Machine-made - these papers are manufactured in rolls, pads or single sheets and commonly referred to as Cartridge paper. They are available in three thicknesses ranging from thin, medium to stout and have a ‘right’ and a ‘wrong’ side, with the wrong side having a slightly pitted surface.
The surface is suited for use with pencil and ink pens but is not suited to ink washes or gouaches, as it tends to buckle and warp. White cartridge paper is considered to be the best quality as opposed to the cream coloured papers.

Tracing paper - this material may be of specially treated paper or linen and polyester film, which is semi-transparent or completely transparent. They are useful for copying or tracing details when the film is placed over the image, as the line work of the original shows through. It is manufactured in rolls, pads and single sheets and is available in grades of thin, medium and stout with either smooth or rough surfaces. The smooth surfaces are best for pencil, however the rough sides can wear the tips of ink pens, therefore it may be necessary to purchase pens with a toughened tungsten tip.

Standard paper sizes

Paper is available in a range of sizes with the most commonly used for trade drawings being A2, A3 and A4.:

Table 4

PAPER DESIGNATION	SIZE
A0	1 682 x 1 198
A1	841 x 1 198
A2	841 x 594
A3	420 x 297
A4	219 x 297